



Utilizing Higher Resolution Land Surface Remote Sensing Data for Assessing Recent Trends over Asia Monsoon Region

-- A Sample Study of Using Data at NASA MAIRS Data Center

Suhung Shen

Gregory Leptoukh

NASA Goddard Earth Sciences Data and Information Services Center



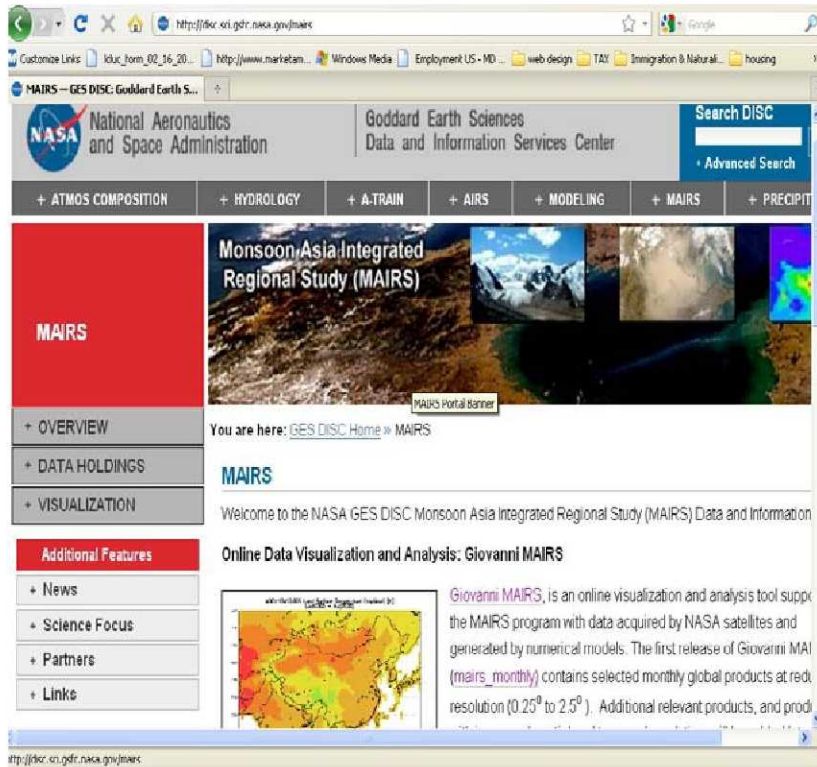
Outlines:

- About NASA MAIRS Data Center
- Introduction of data access tools
- Introduction of Products available
- Higher resolution Land Surface Temperature
- Preliminary Result of LST Trend over China



NASA MAIRS Data Center

<http://disc.gsfc.nasa.gov/mairs>



Goals:

- *Leverage the infrastructure, tools, and data of the successful NASA NEESPI Data Center project*
- *Provide the NASA satellite remote sensed and Modeled land, atmospheric, and oceanic data and their subsets over the Asian monsoon region*
- *Work with MAIRS scientists to collect ground-based, as well as regional model data and to promote data sharing*



Access Data and Information:

Data Archived at GES DISC

NASA Satellite measurements and model data

- Provides ftp or http download
- Provides search and download tool: Mirado
- Provide subset of data: OPeNDAP, GDS
- Provide visualization and analysis tools: Giovanni

Data Not Archived at GES DISC

Based on MAIRS scientist's need, collect satellite, model, ground-based data and information and will provide product metadata, such as product name, measurement, data format, data location, person of contact, etc.



Data Access: Mirador – Simple Search

A drastically simplified, clean interface that employs the Google mini appliance for metadata keyword searches.

http://mirador.gsfc.nasa.gov/

Mirador Earth Science Data Search T...

+ GES DISC Home

Mirador

+ OVERVIEW

+ HELP CENTER

+ DATA HOLDINGS

+ VIEW CART

Additional Features

+ News

+ Restricted Data

+ Feedback

+ FAQ

Mirador
Data Access Made Simple

You are here: [Keyword Search](#)

Keyword Projects Science Areas

SEARCH MIRADOR

Keyword: MODV1.005 Location:

Advanced Search

Time Span

From: To:

Search

Available: [AIRS, OMI, MLS, HIRDLS, TOMS, UARS, TRMM, GLDAS, SORCE, Subsets from A-Train Sensors \(e.g. MODIS, AIRS, OMI and MLS\)](#)

What's New: [View GES-DISC Data by NASA Science Area](#) [Search TRMM Orbital data by % missing data](#)

OpenSearch

Mirador supports Searching by:

Keyword

Time span

Location

Mirado supports Navigation by:

**Projects
Science Area**



Data Access: Giovanni MAIRS

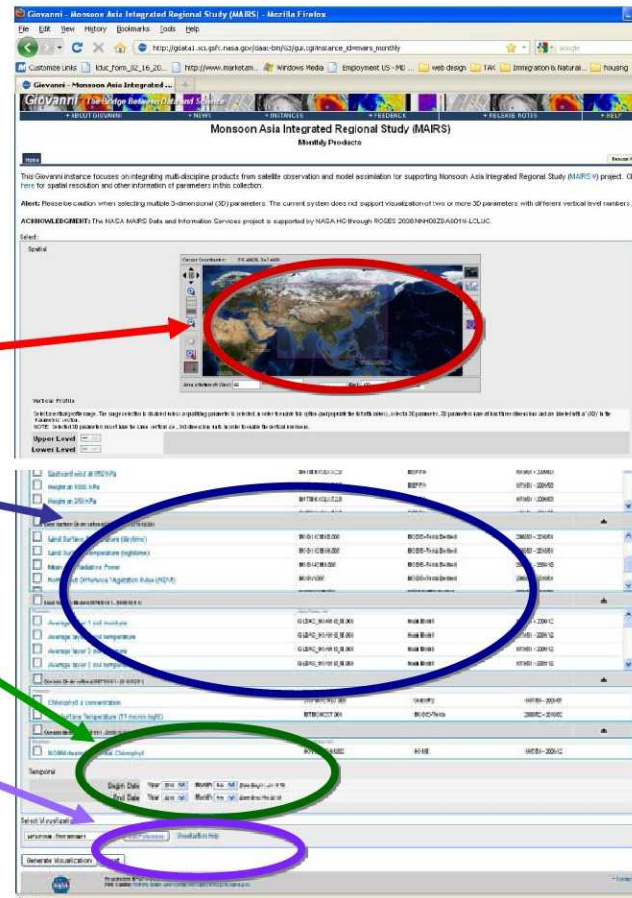
Users simply make selection criteria:

Spatial Area

Parameters

Time Range

Visualization Function



- Customizable interface
- No need to install software; No need to download and process data
- Provide visualization and basic statistical analysis functions (time series, scatter plot, difference, etc)
- Able to download different format images (gif, KMZ) or data (ASCII, NetCDF, HDF)



Products in MAIRS Giovanni

Group	Parameter Name	Sensor Name	Available Since	Time Interval	Spatial res.(deg)
Meteorology	Winds, Pressure, Geopotential Height, Air Temperature , Water Vapor	MERRA	1979.01	Monthly	2/3 x 1/2
	GPCP precipitation	GPCP	1979.01	Monthly Daily	1.0x1.0
Atmospheric Chemistry	Aerosol Optical Depth	MODIS	2000.02	Monthly Daily	1.0x1.0
	NO2	OMI	2004.08	Daily	0.25x0.25
	CH4, CO	AIRS	2002.08	Monthly Daily	1x1
Land Surface (Higher Resolution)	Land Cover Type & Dynamics	MODIS (MOD12Q1)	2001	Yearly	1 km
	Vegetation Indices	MODIS (MOD13A1)	2000.03	Monthly 16-day	1.0x1.0 1 km, 5 km
	Land Surface Temperature	MODIS (MOD11A2)	2001.03	Monthly 8-Day	1.0x1.0 1 km
	Thermal anomalies/Fire	MODIS (MOD14A2)	2000.03	Monthly 8-Day	1.0x1.0 1 km
	Total Evapotranspiration, Snow Water Equivalent	GLDAS	1979.01	Monthly	1x1
	Surface Runoff, Soil Moisture	GLDAS	1979.01	Monthly	1x1
Ocean	Chlorophyll a concentration	SeaWiFS	1997.09	Monthly	9 km
	Sea surface temperature	MODIS-Terra	2000.02	Monthly	9 km
Socio-economic	Nighttime Lights	DMSP-OLS	1992-2003	yearly	1 km



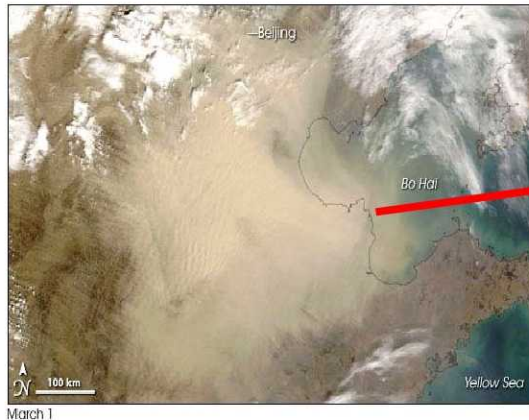
Sample Plots through MAIRS and Other Giovanni interface



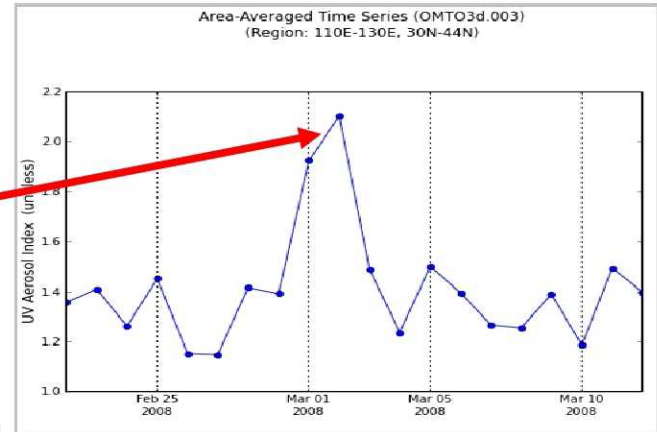
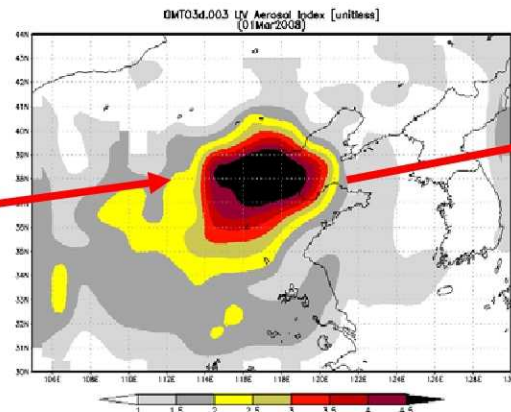
Dust Storm over East China

Mar 1-2 2008

MODIS-Terra True Color Image



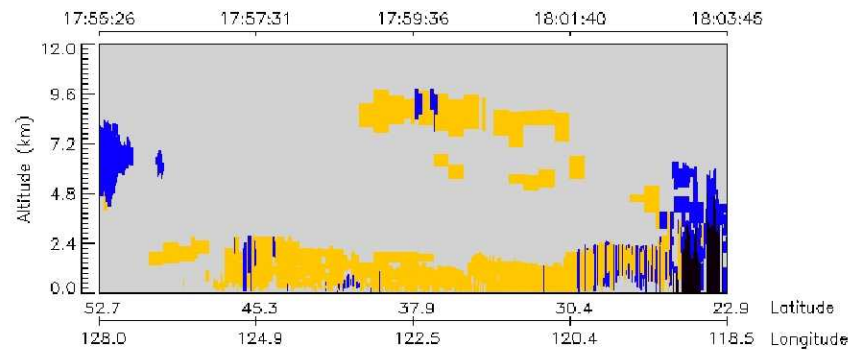
Daily UV Aerosol Index from OMI



Cloud/Aerosol Classification (Vertical Feature Mask) (Calipso - Lidar)

29-Feb-2008 17:55:26 - 18:03:45 GMT

Clouds Aerosols Stratospheric Clouds Total Attenuation

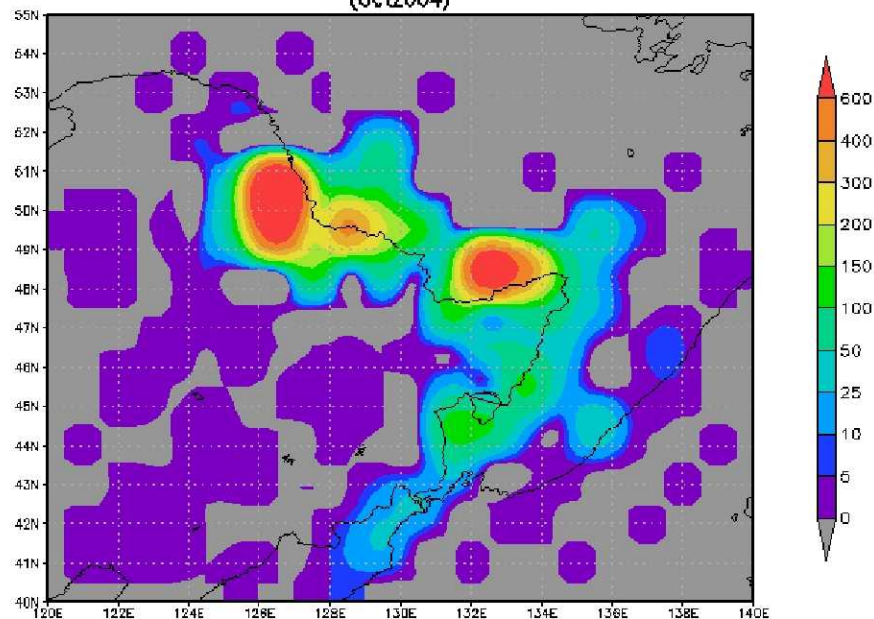


**Cloud/Aerosol classification from
Calipso-Lidar shows vertical feature of
aerosol on Feb 29 18Z 2008**

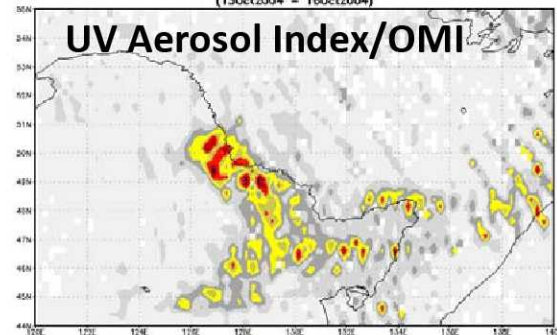


Fires in Northeast China Oct 14-19 2004

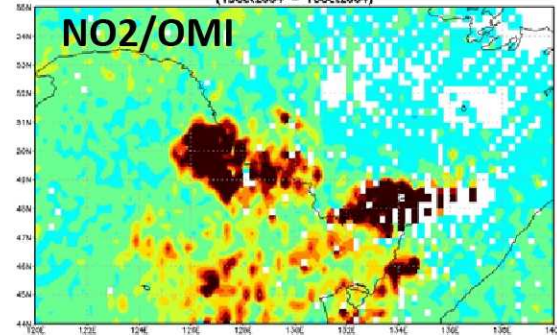
MOD14CM1.005 Cloud and Overpass Corrected Fire Pixel Count [unitless]
(Oct2004)



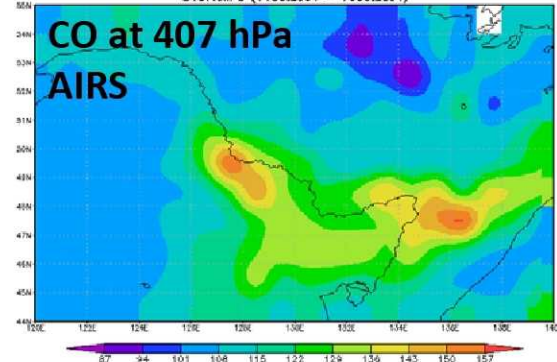
OMT03G.003 UV Aerosol Index [unitless]
(13Oct2004 - 19Oct2004)



OMN020.003 NO2 Column Amount (Clear, 0-30% Cloud) [10^{15} molec/cm²]
(13Oct2004 - 19Oct2004)



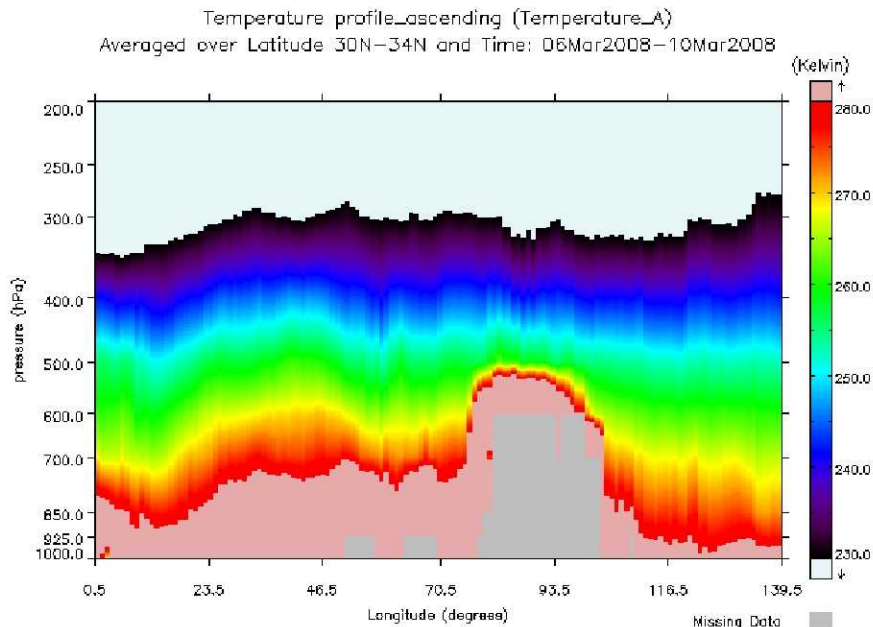
AIRX3STD.005 CO volume mixing ratio ascending (CO VMR off_A) [10^{-9} vmr]
@407.0hPa (14Oct2004 - 19Oct2004)



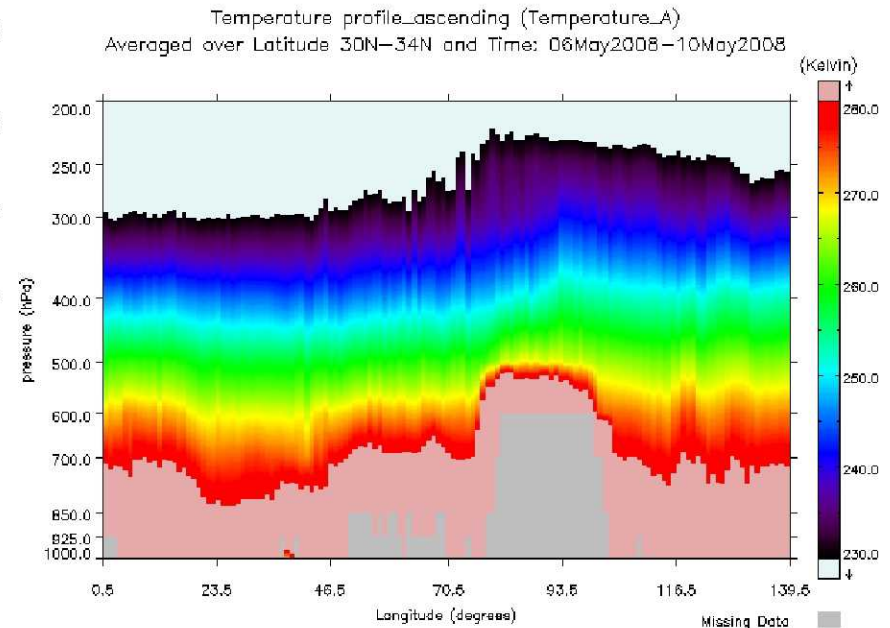
MODIS fire pixel counts of Oct 2004 (above). The forest fire broke out on Oct. 14 2004 afternoon in Heihe, Helongliang, China, lasted for about 6 days. Averaged UV aerosol index, N2O from OMI, and CO from AIRS for Oct 13-16 2004 (right).



AIRS Observed Temperature Vertical Cross Section for 30°N-40°N



Spring heating of atmosphere above Tibetan Plateau associated with Monsoon onset



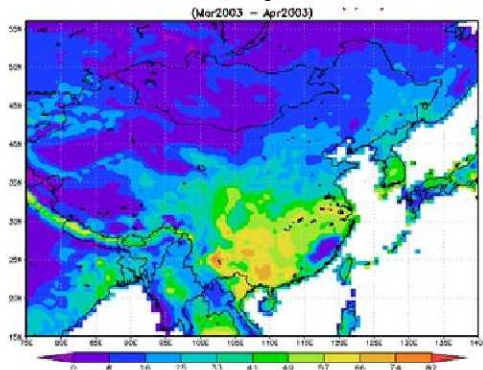
Other AIRS data: Water vapor, Geopotential height, pressure, OLR, CH₄, CO, etc.

Info: AIRS subsets are supported for selected CEOP sites by GES DISC AIRS team

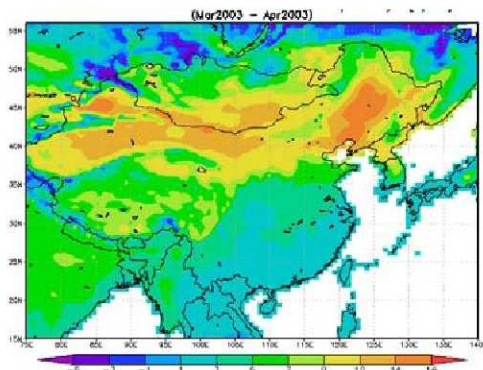


MERRA - NASA Reanalysis Products (1979 – present)

Bare Soil Evaporation



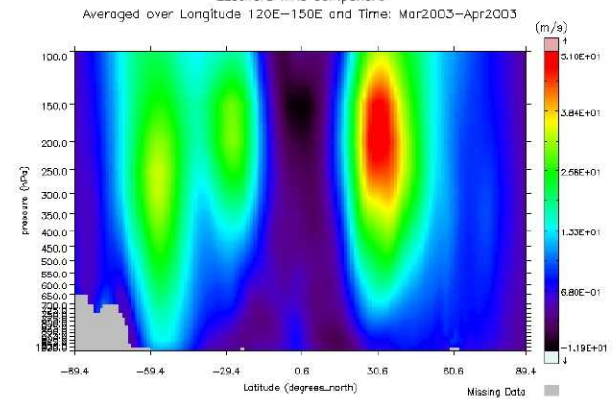
Downward Heat Flux



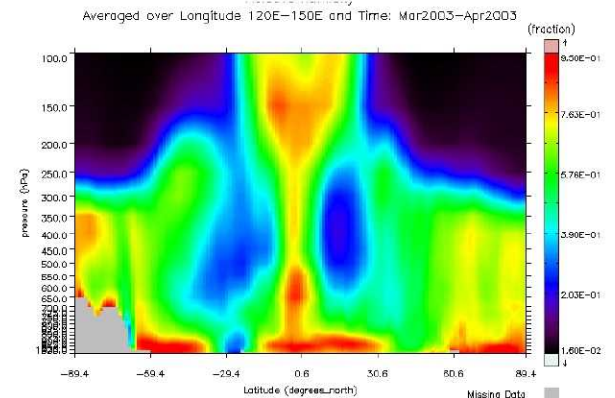
MERRA is a NASA reanalysis for the satellite era using GEOS-5, focusing on historical analyses of the hydrological cycle on a broad range of weather and climate time scales.

Products include land surface, meteorology, energy budget parameters, available in monthly, or hourly at resolution of $2/3^\circ \times 1/2^\circ$, $1.25^\circ \times 1.0^\circ$, or $1.25^\circ \times 1.25^\circ$ with 42 or 72 levels depending on parameters

Eastward Wind

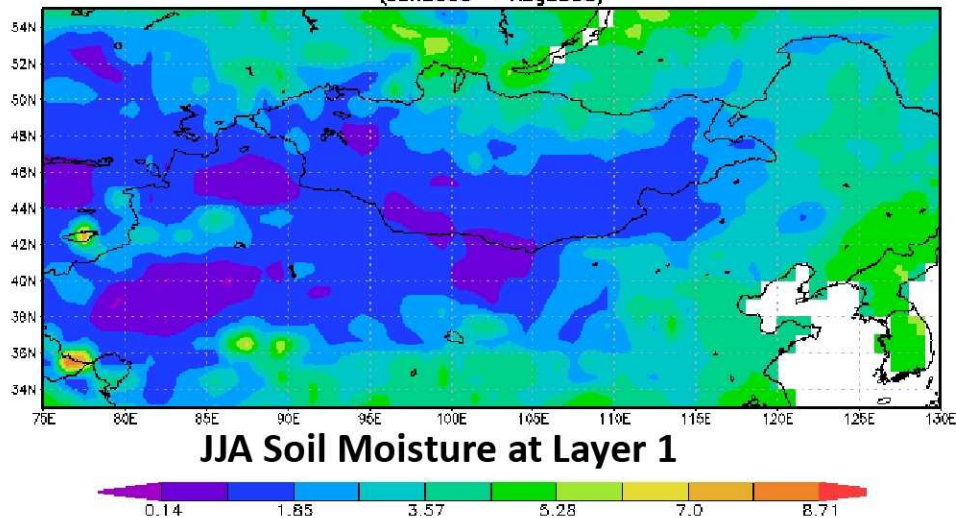


Relative Humidity



GLDAS - NASA Hydrology Model Products (1979 – present)

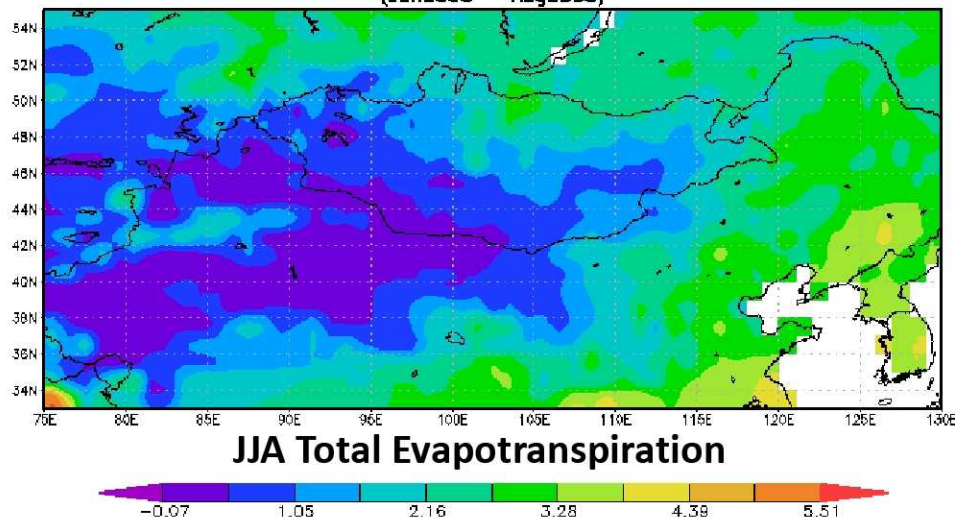
GLDAS_CLM10_M.001 Average layer 1 soil moisture [kg/m^2]
(Jun2008 – Aug2008)



GLDAS data at temporal resolution of 3 hourly and monthly, can be accessed through direct ftp as well as search and order system at GES DISC (<http://disc.gsfc.nasa.gov/>)

GLDAS data are from four different land surface models (CLM, MOS, NOAH, and VIC), all at 1.0° resolution and some at 0.25° resolution as well.

GLDAS_CLM10_M.001 Total evapotranspiration [$((10^{-5})\text{kg/m}^2/\text{s})$]
(Jun2008 – Aug2008)





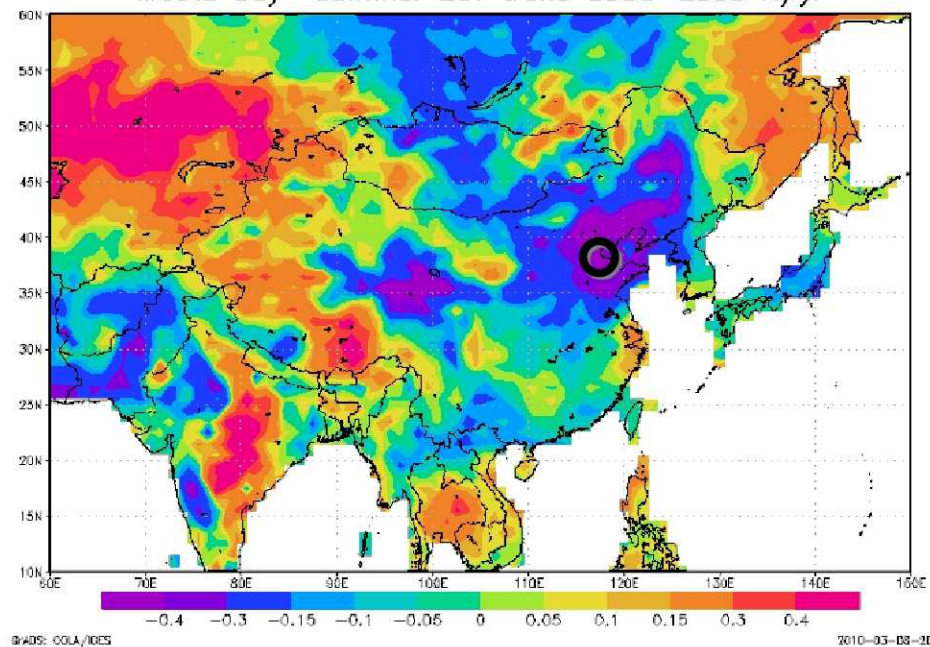
Preliminary Results from MODIS-Terra:

Recent Trend of Land Surface Temperature over Asia Monsoon Region

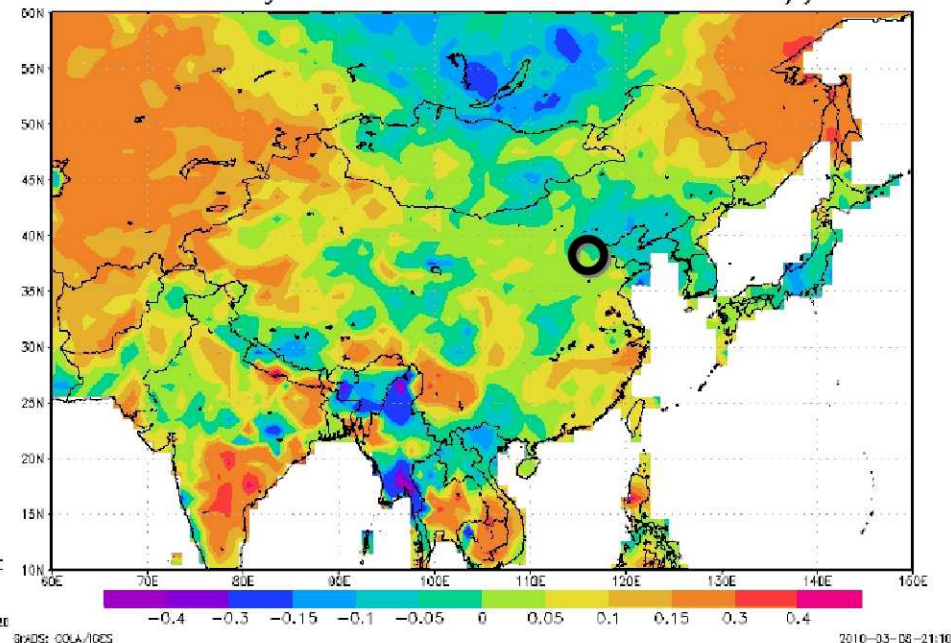


Bigger Area View of LST Recent Trend from MODIS-Terra1x1 degree resolution

MODIS Day Summer LST trend 2000–2009 K/yr



MODIS Night Summer LST trend 2000–2009 K/yr





MODIS-Terra 8-day 1km product (MOD11A2.005)

(from MODIS Land Surface Temperature Products Users' Guide, by Zhengming Wan, April 2009)

- Retrieved by using generalized split-window algorithm, using Level 1B radiance data in bands 31 and 32
- Under Clear Sky condition, clear sky pixels defined by MODIS cloudmask product with: confidence $\geq 95\%$ over land and $\geq 66\%$ inland water
- Cloud-contaminated LST are removed
- Two LST: Daytime (local time at ~ 10 -11 am) and Nighttime (local time at ~ 10 -11 pm)
- Sinusoidal projection, 10x10 degree tile, HDF-EOS
- Quality: QA flag, in general, for QA flag=good, accuracy is better than 1 K, but
- Large uncertainty may exist in semi-arid and arid areas



Approach:

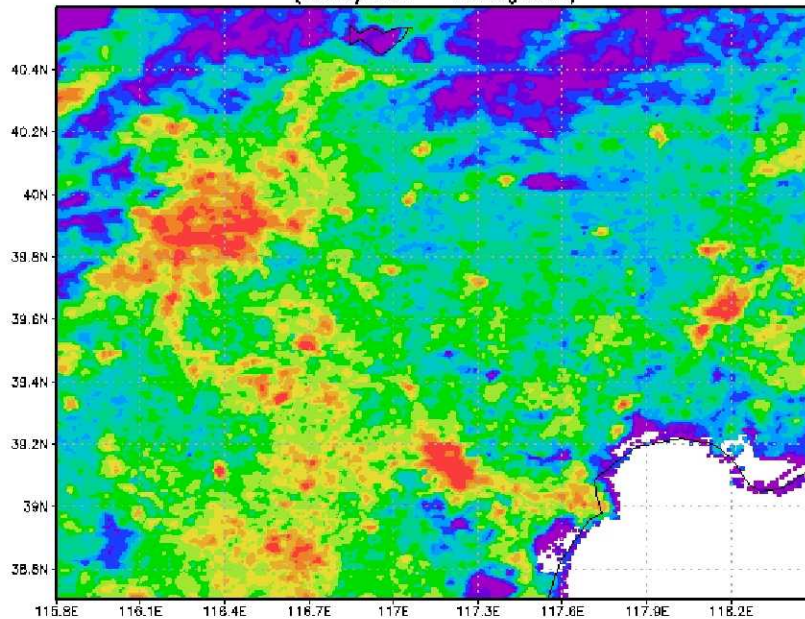
- Using MODIS Reprojection Tool (MRT) software
 - Mosaic 10x10 degree tiles into Asian Monsoon region, 0-60N , 60E-150E
 - Project to Cylindrical Equidistant project
 - Center point of project is (0, 0)
 - Output data format: HDF-EOS
-
- Kept all quality Level
 - Averaged summer time LST (June, July, August), 2001-2009
 - Compute linear regression fit for each grid point



Summer Daytime LST near Beijing-Tianjing Region

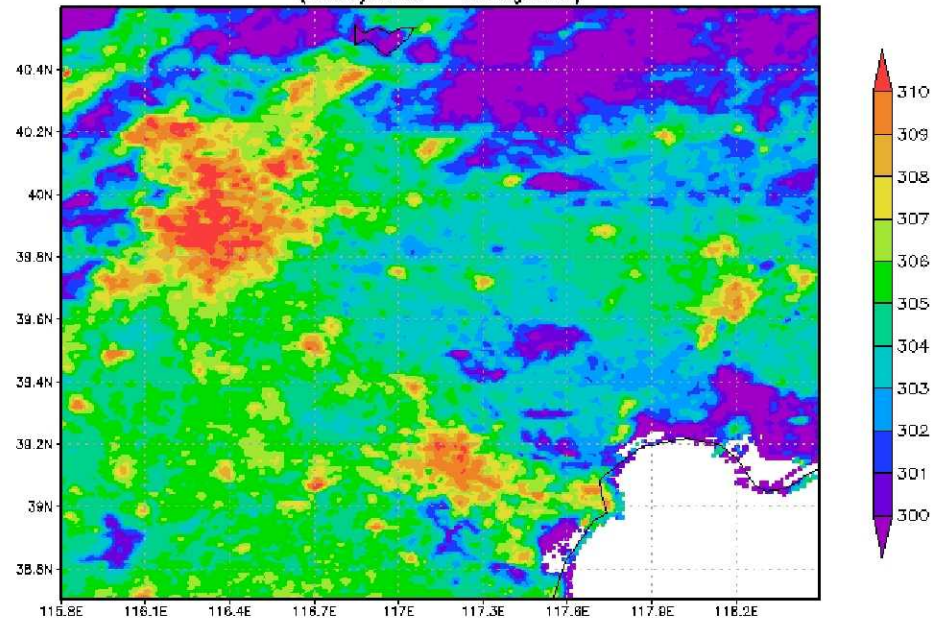
2001 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2001 - 29Aug2001)



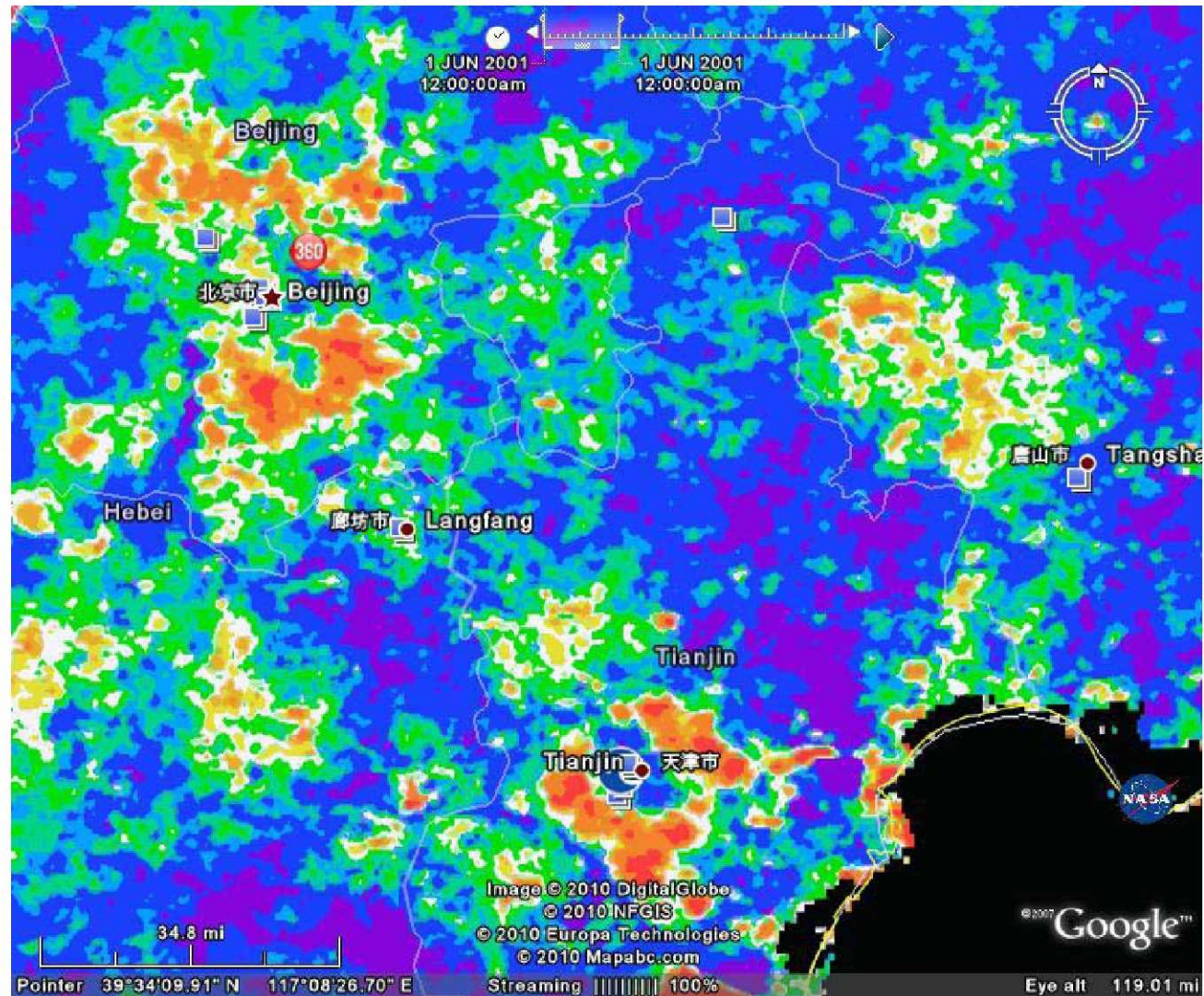
2009 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2009 - 29Aug2009)





MODIS 1km Summer Daytime LST Trend 2001-2009 JJA



K/Yr

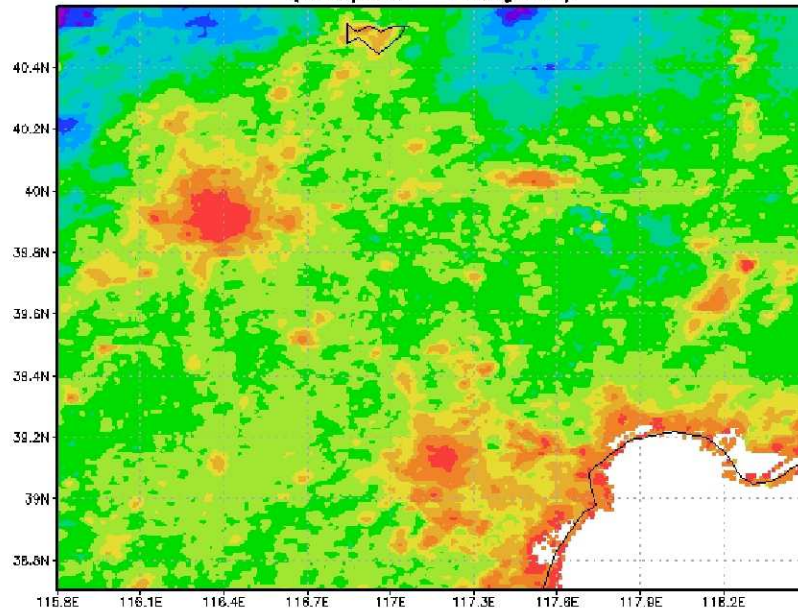
Mar 22-24 2010



Summer Nighttime LST near Beijing-Tianjing Region

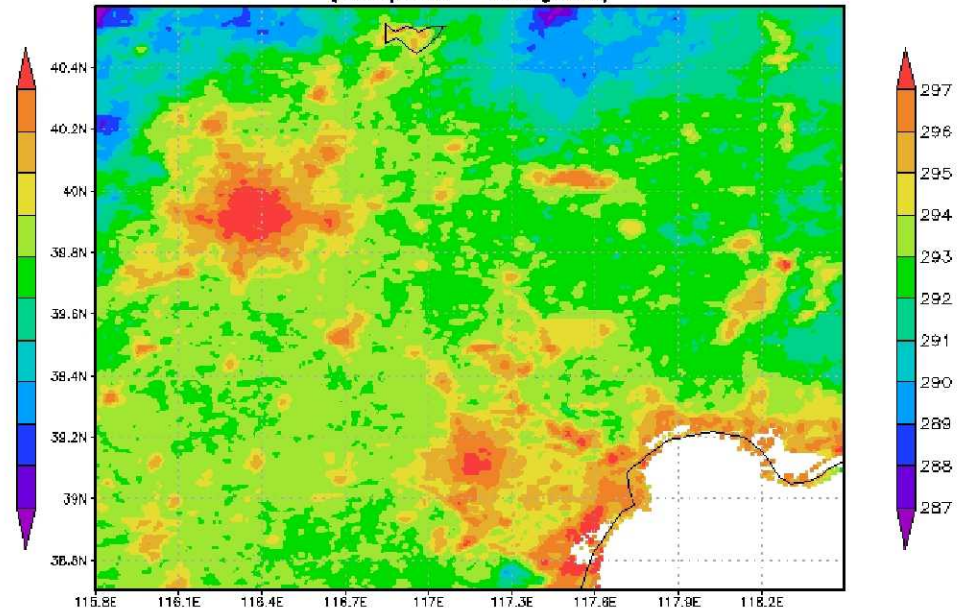
2001 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (night) [K]
(25May2001 - 29Aug2001)



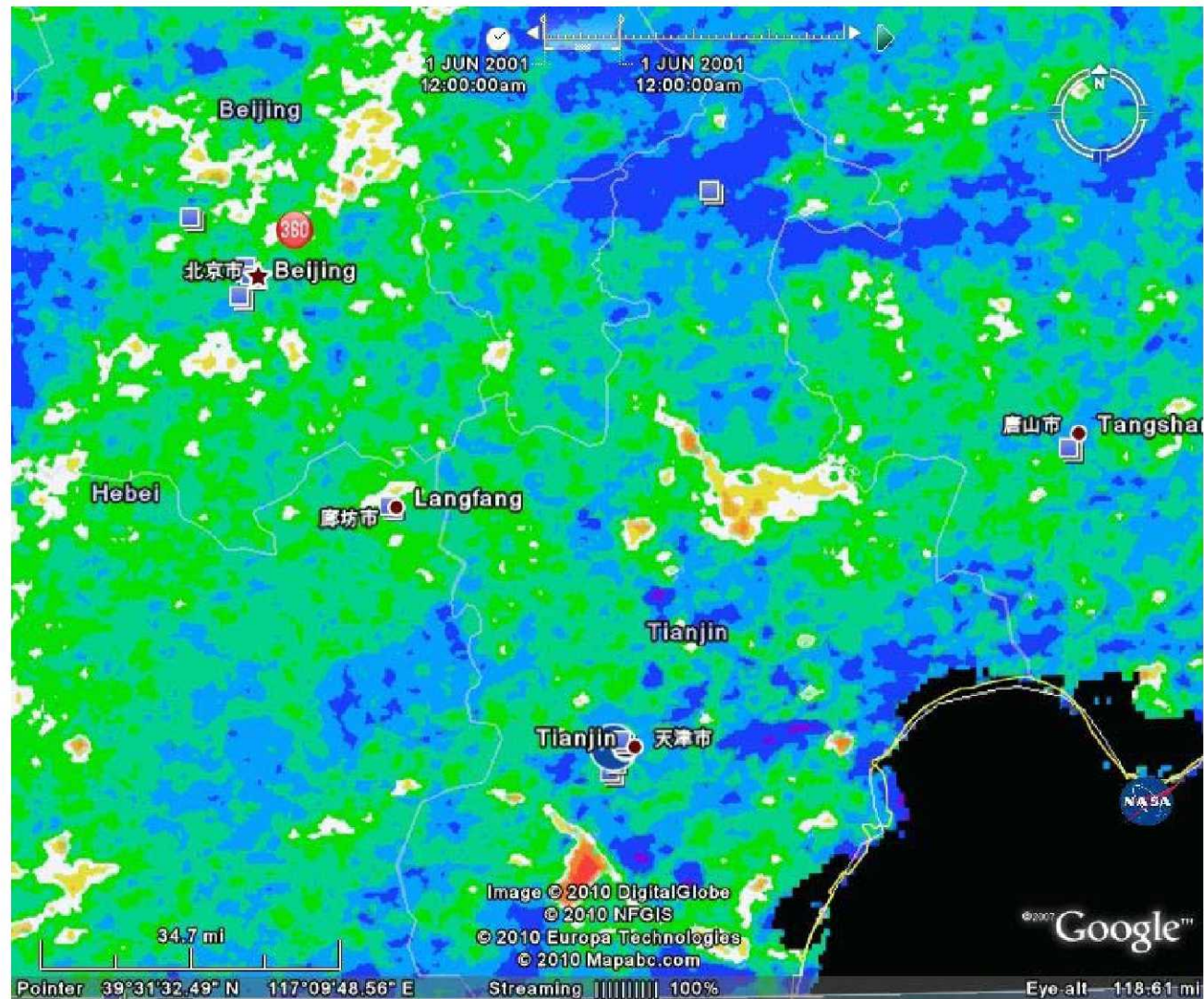
2009 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (night) [K]
(25May2009 - 29Aug2009)





MODIS 1km Summer Nighttime LST Trend 2001-2009 JJA



Mar 22-24 2010

-0.3 -0.15 -0.1 -0.05 0 0.05 0.1 0.15 0.3

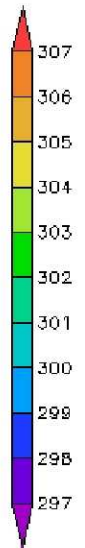
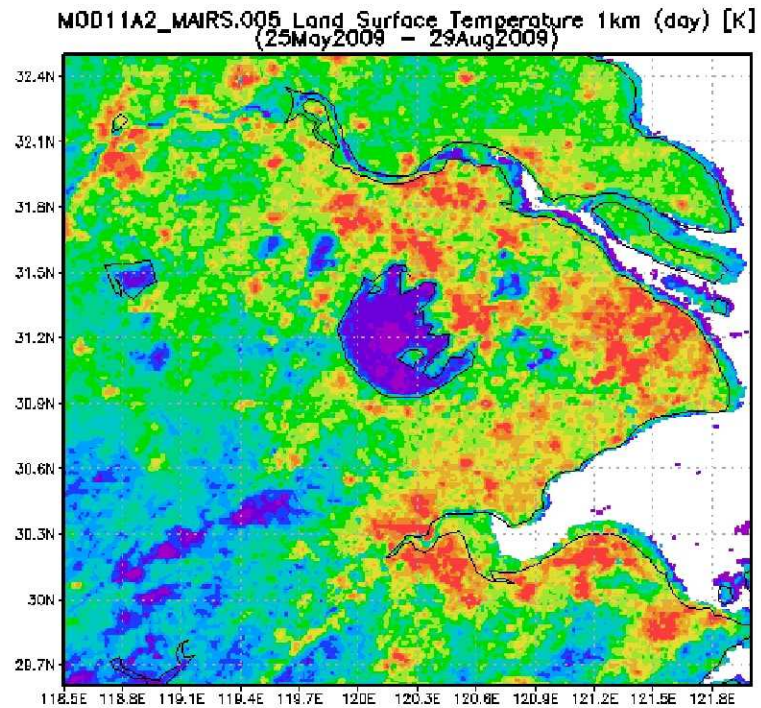
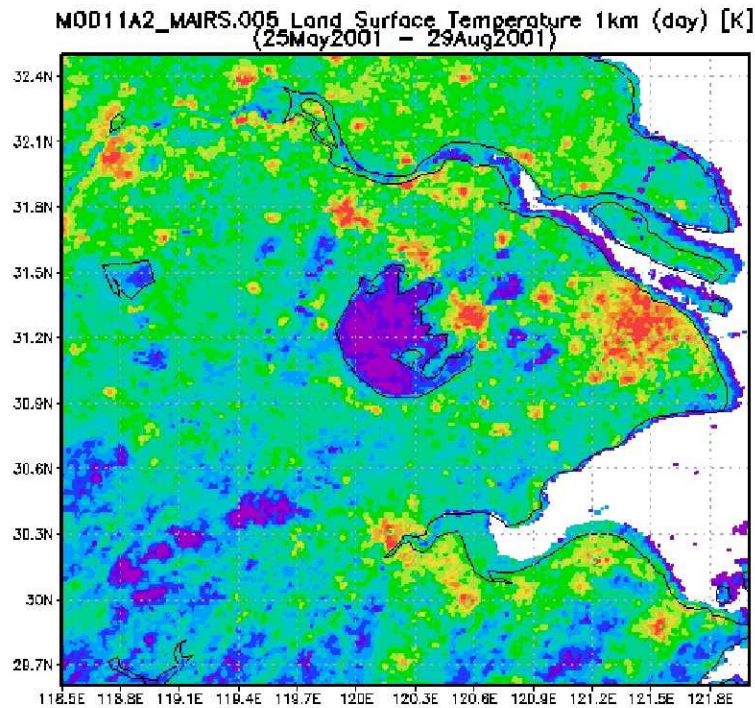
K/Yr



Summer Daytime LST at Yangtze River Delta

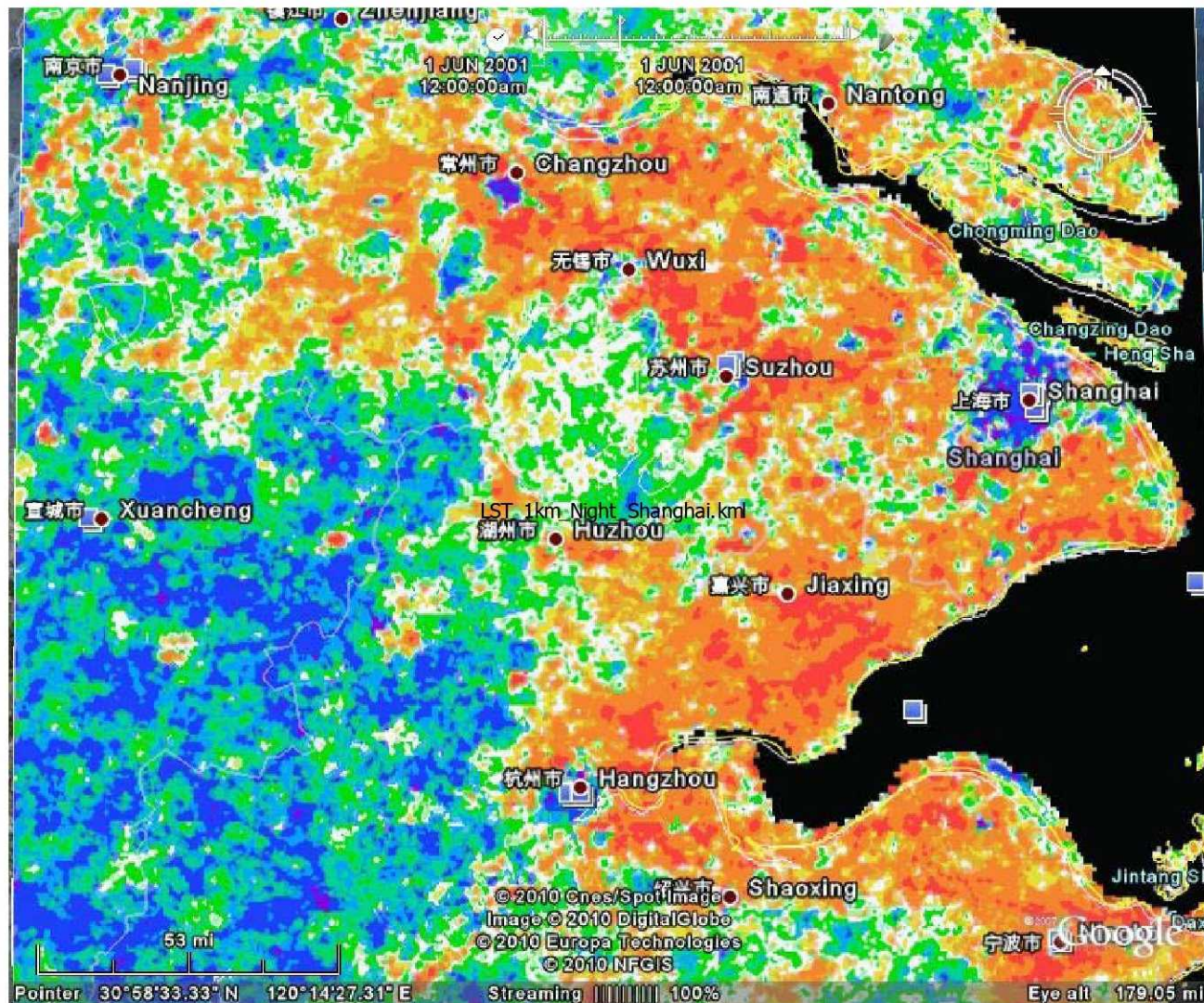
2001 JJA

2009 JJA





MODIS 1km Summer Daytime LST Trend 2001-2009 JJA



Mar 22-24 2010

-0.3 -0.15 -0.1 -0.05 0 0.05 0.1 0.15 0.3

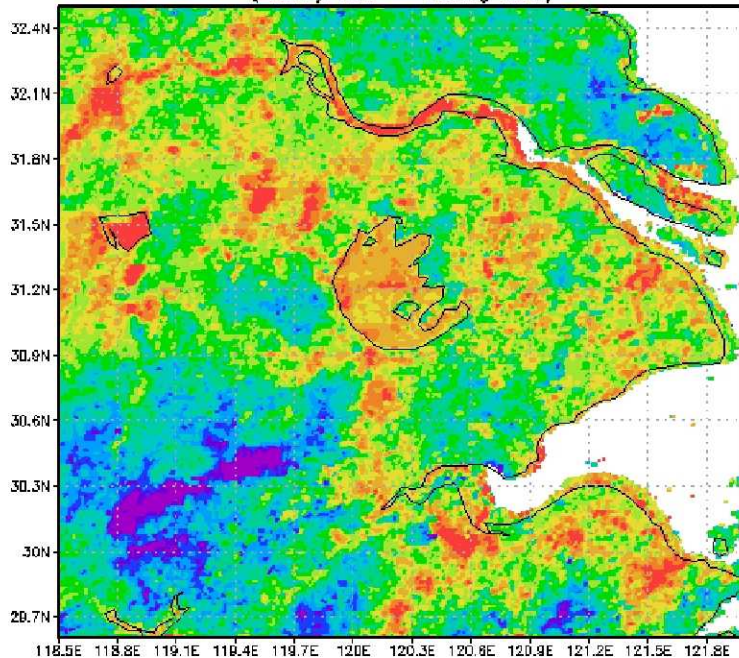
K/Yr



Summer Nighttime LST at Yangtze River Delta

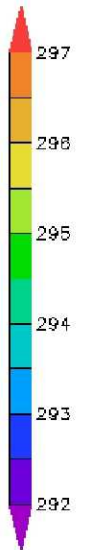
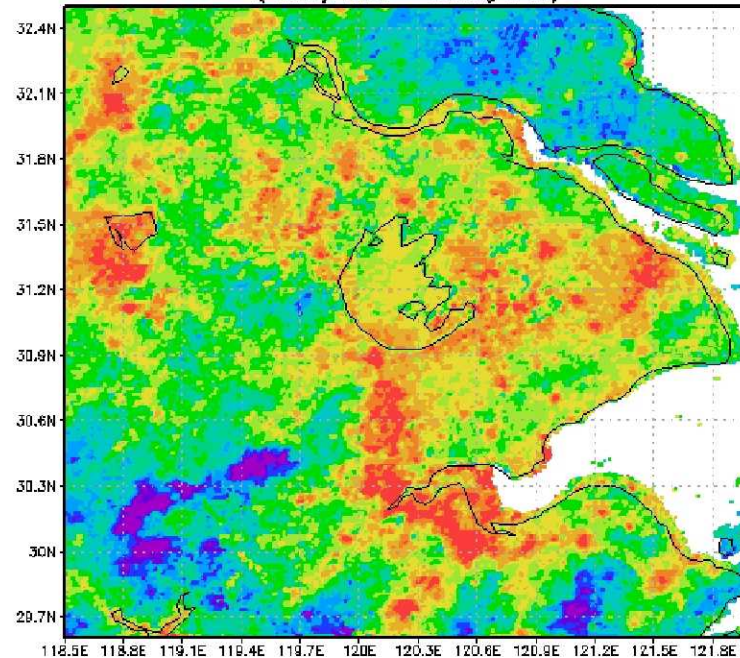
2001 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (night) [K]
(25May2001 - 29Aug2001)



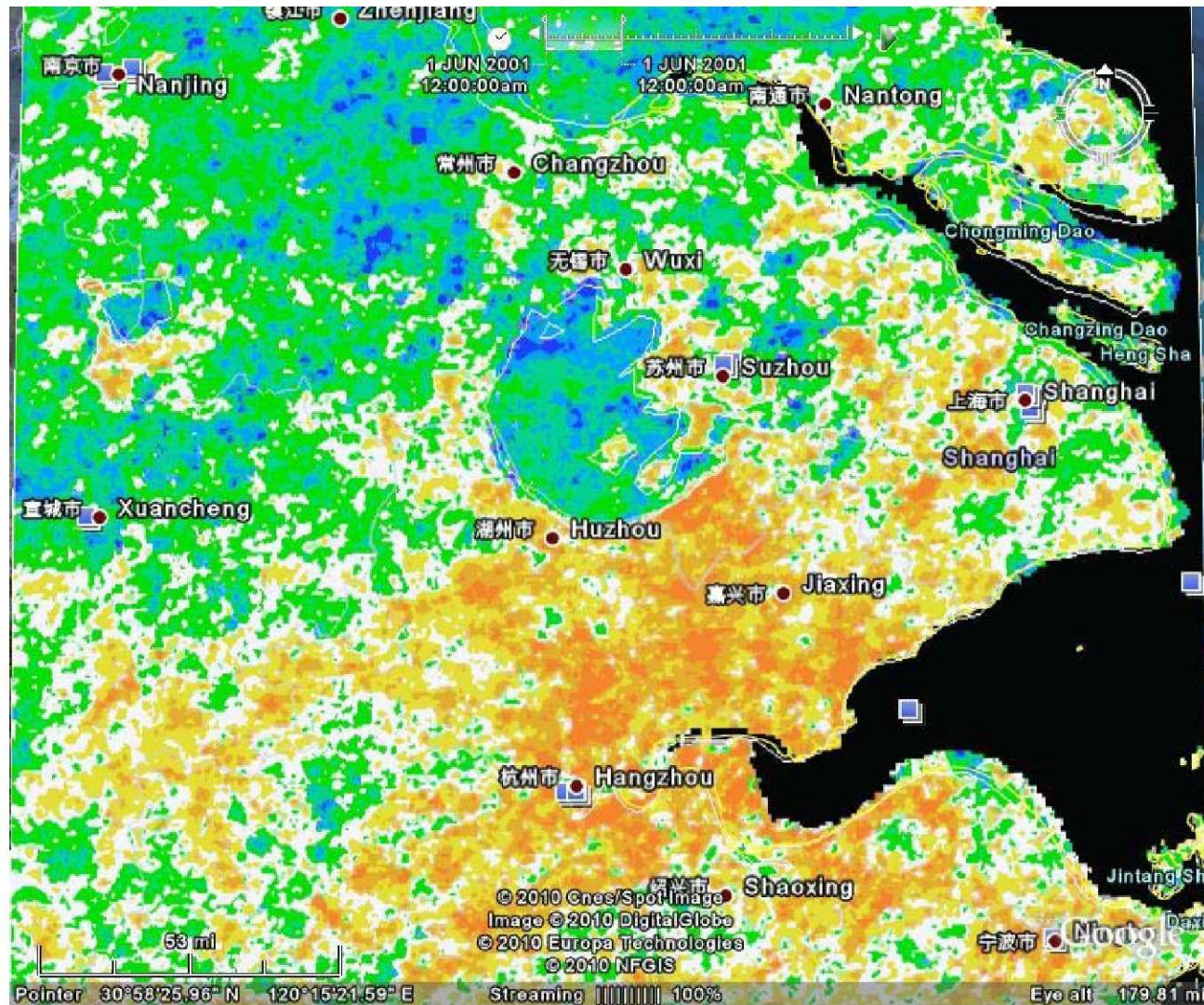
2009 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (night) [K]
(25May2009 - 29Aug2009)





MODIS 1km Summer Nighttime LST Trend 2001-2009 JJA



K/Yr

Mar 22-24 2010



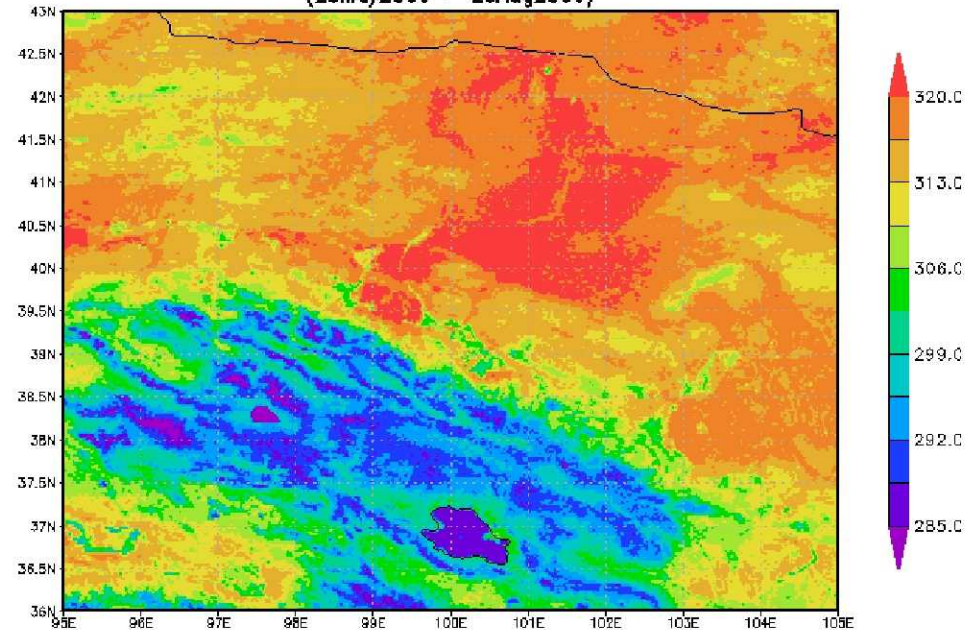
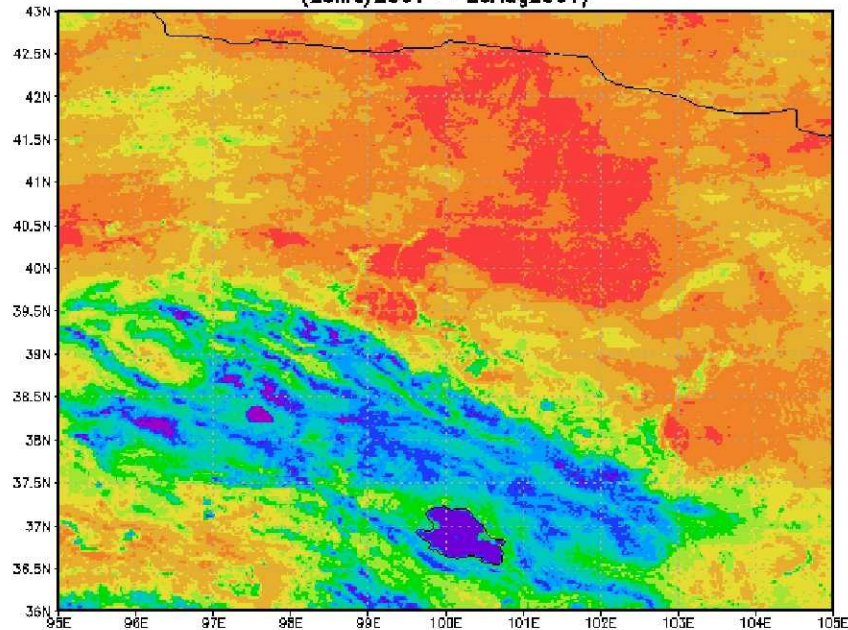
Summer daytime LST at Northern China

2001 JJA

2009 JJA

MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2001 - 29Aug2001)

MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2009 - 29Aug2009)





MODIS 1km Summer Daytime LST Trend 2001-2009 JJA



Summary:

Higher resolution (1 km) data enables to show detailed spatial structure of LST associated Urbanization. For the fast changing Beijing-Tianjing and Yangtze River Delta regions, from 2001 to 2009:

- Daytime LST is warming in the urbanized Zone (surrounding area of cities), but is cooling in the developed (center of city) and rural areas.
- Nighttime LST change amount is less than Daytime, significant warming near Hangzhou –Shanghai regions

MODIS LST collected under **clear sky** condition at about same (within about 2 hours window) local time. Comparisons with ground measurements are highly important to validate the remote sensing results, especially in the dry and semi-dry land.



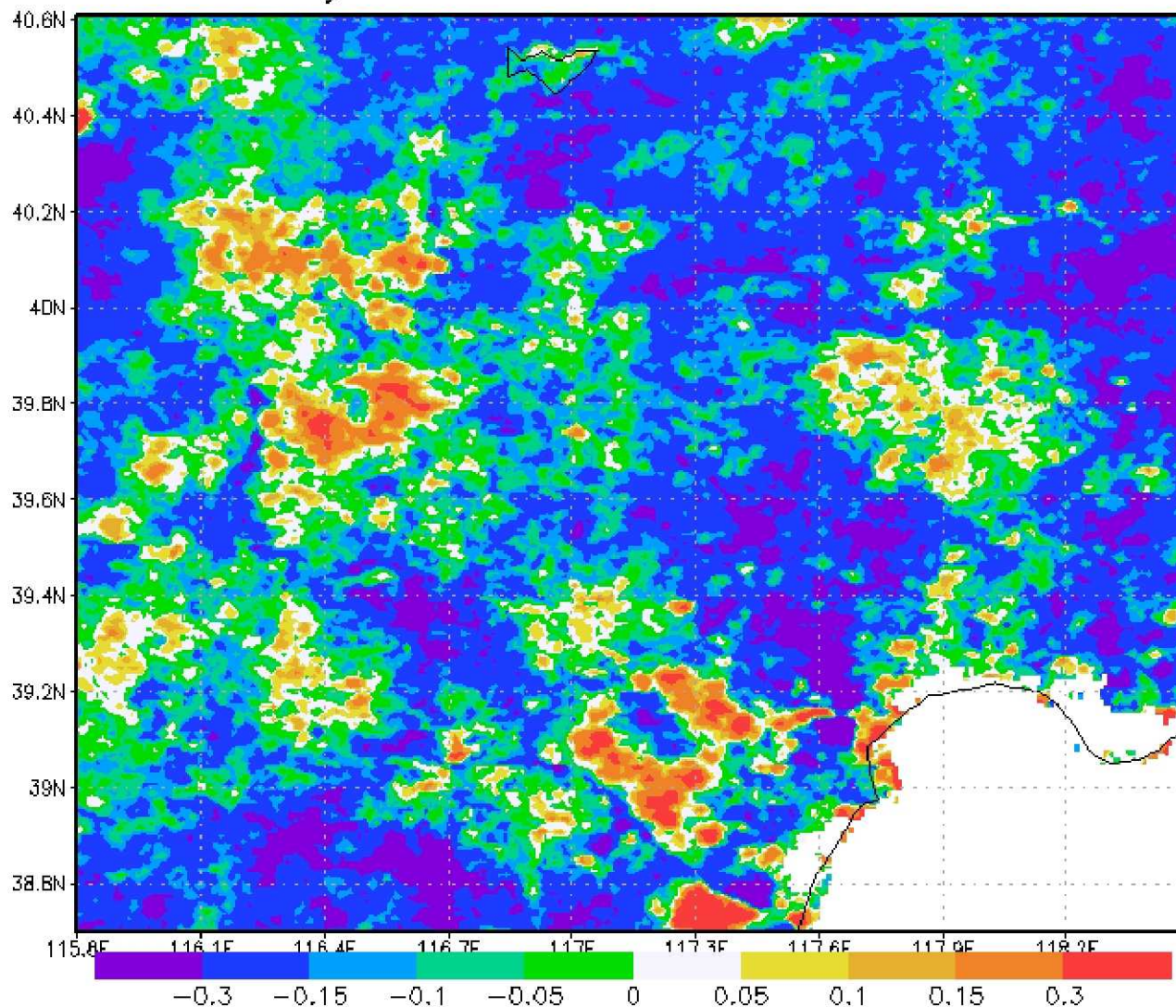
Thank You

<http://disc.gsfc.nasa.gov/mairs>

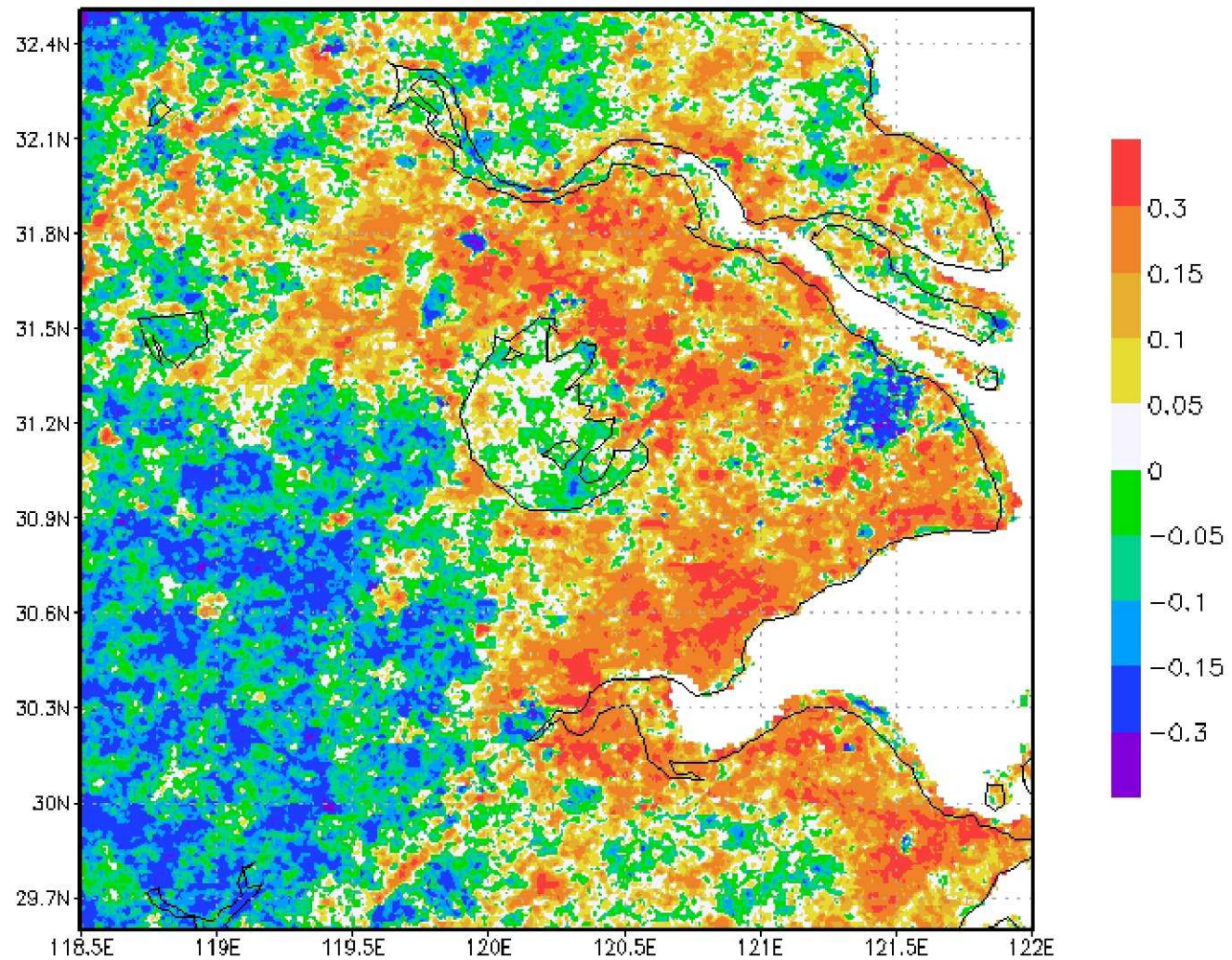
<http://disc.gsfc.nasa.gov>

Suhung.shen@nasa.gov

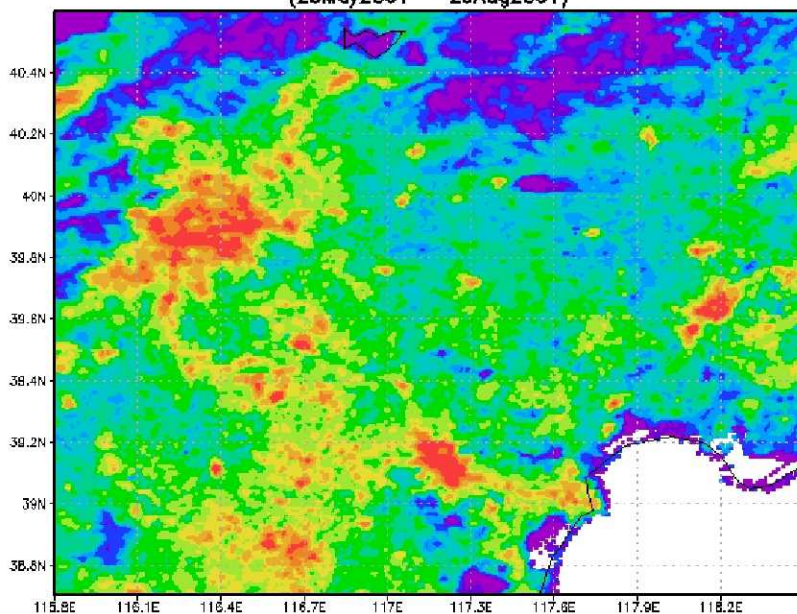
MODIS 1km Daytime Summer LST trend 2001–2009 K/yr



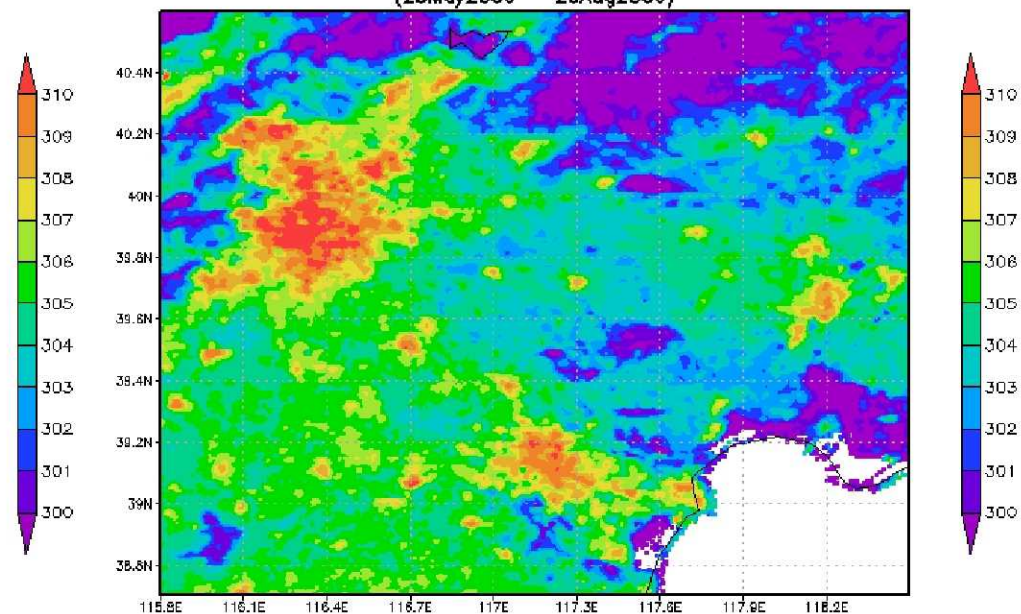
MODIS 1km Daytime Summer LST trend 2001–2009 K/yr



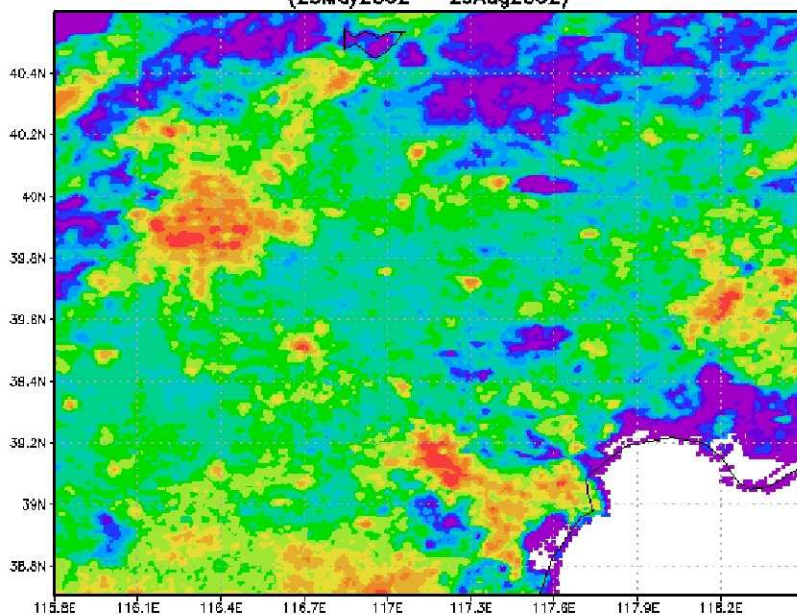
MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2001 - 29Aug2001)



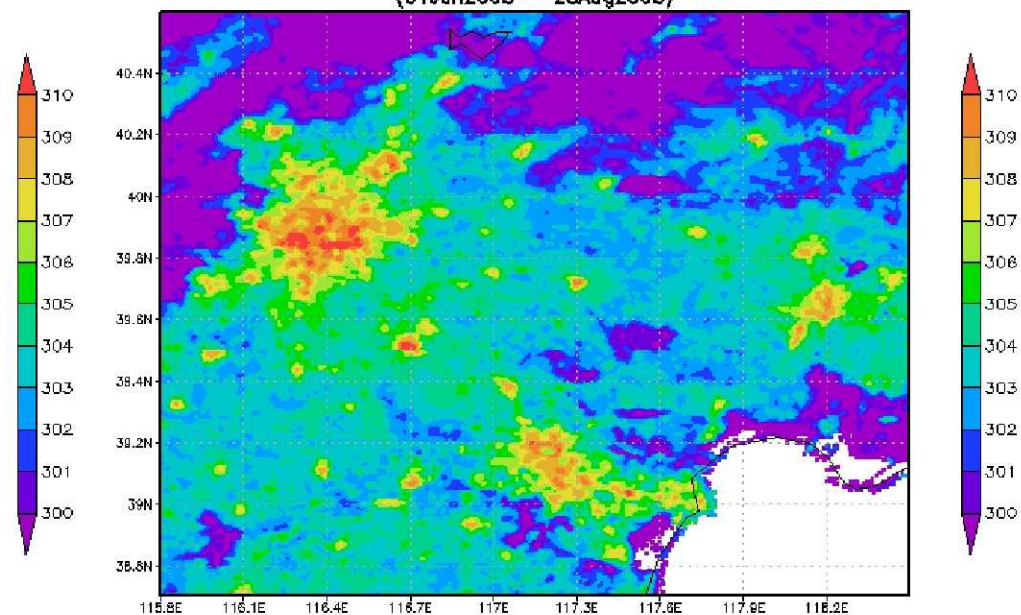
MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2008 - 29Aug2008)



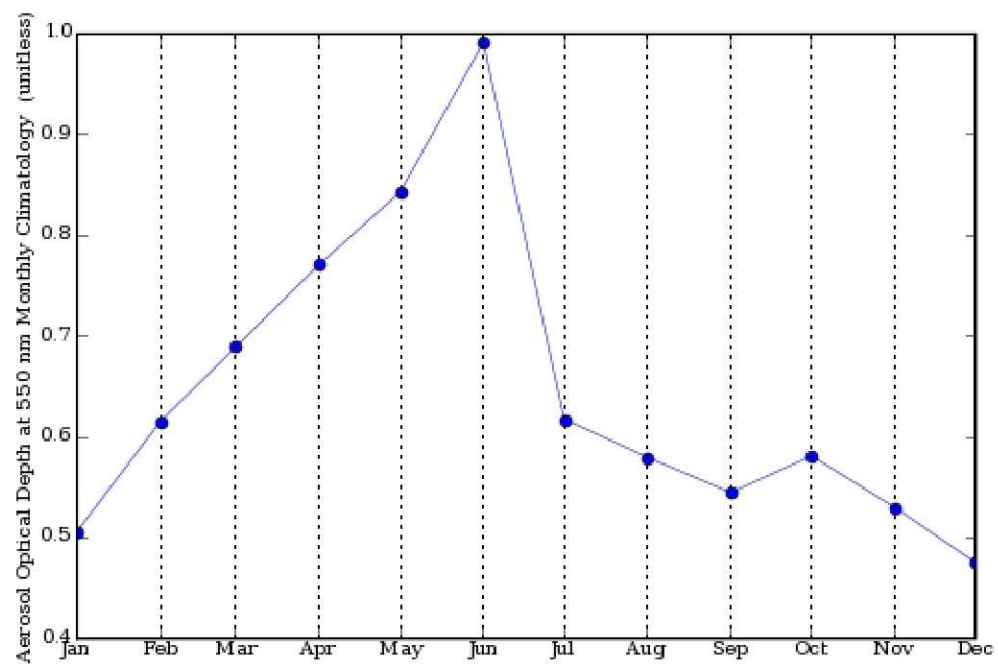
MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(25May2002 - 29Aug2002)



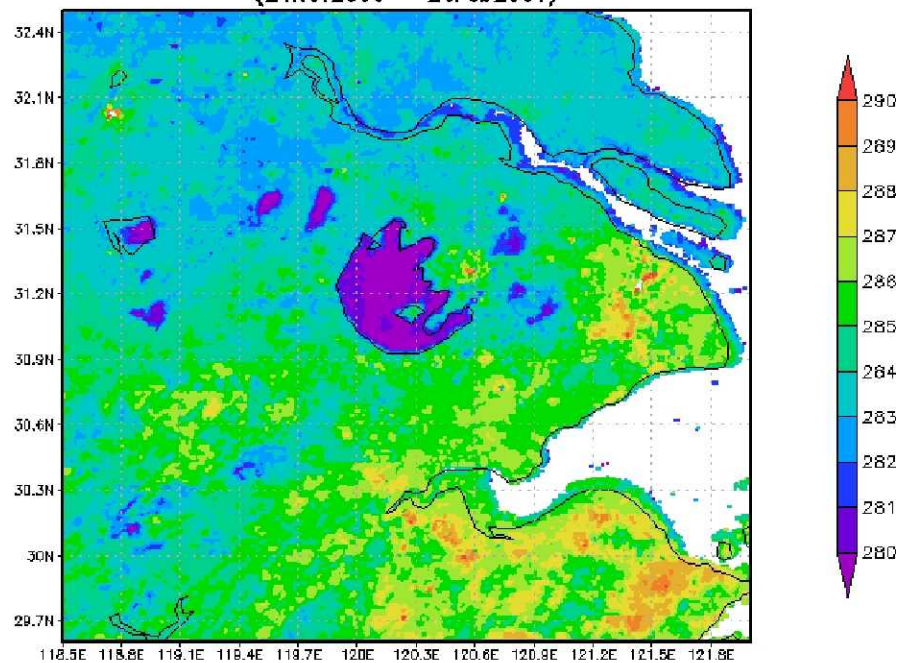
MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(01Jun2008 - 28Aug2008)



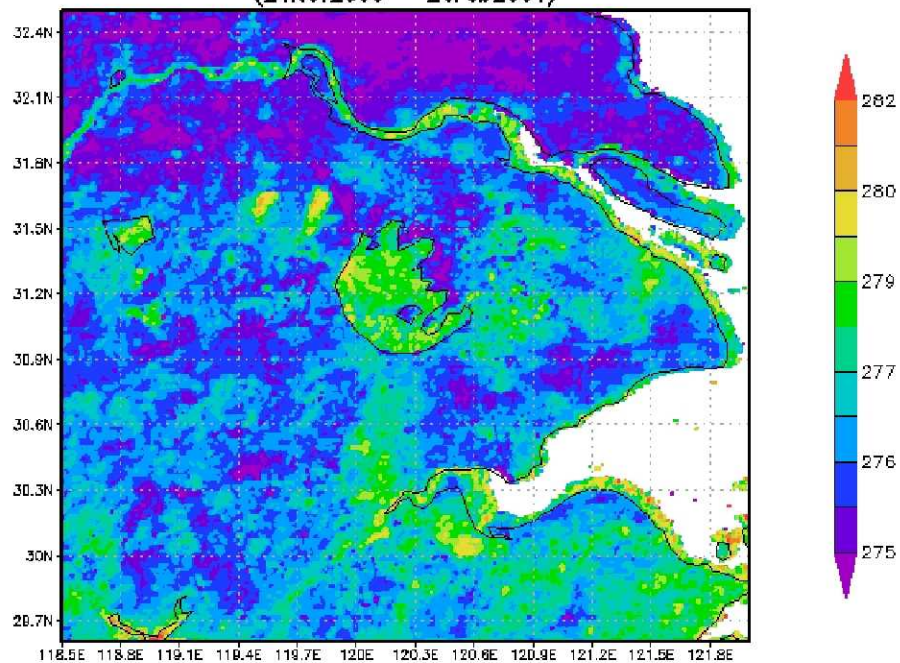
Area-Averaged Time Series (MOD08_M3_CLIM.005)
(Region: 118E-122E, 29N-32N)



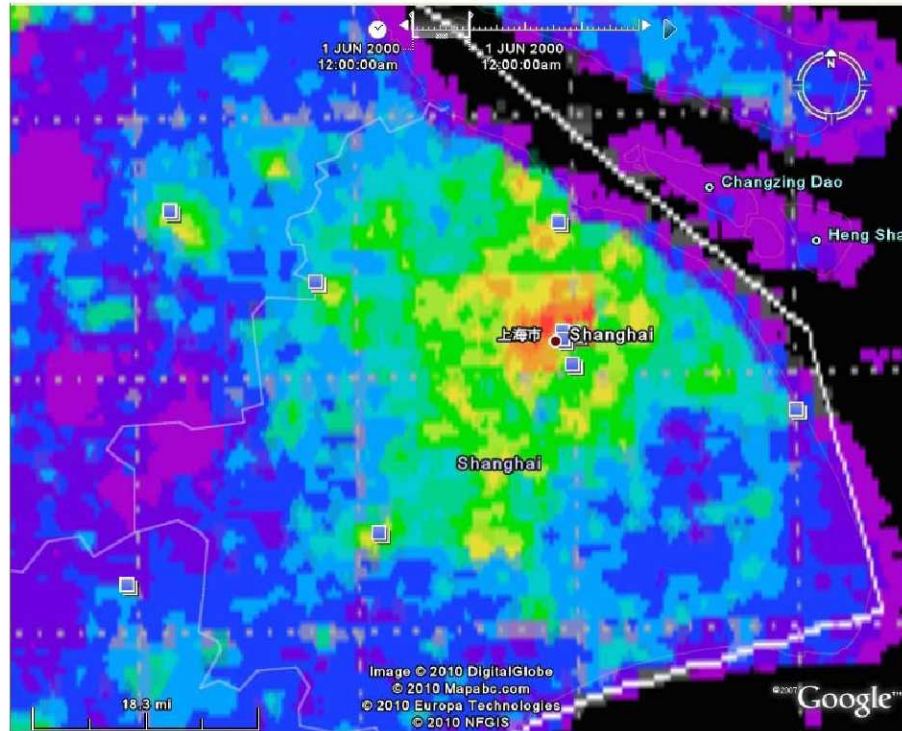
MOD11A2_MAIRS.005 Land Surface Temperature 1km (day) [K]
(24Nov2000 - 26Feb2001)



MOD11A2_MAIRS.005 Land Surface Temperature 1km (night) [K]
(24Nov2000 - 26Feb2001)



Summer 2000



Summer 2009

